M4ShaleGas
Measuring, Monitoring, Mitigating, Managing the Environmental Impact of Shale Gas

Emissions to air and CO_2 footprint related to shale gas operations

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Outline

- Key points
- Types of emissions
- Different sources
- Assessment of emissions
- Carbon footprint (CFP) assessment
- Emission reduction techniques
- Knowledge gaps

Key points

- Emissions to atmosphere have a significant potential environmental impact of shale gas exploration and exploitation.
- How to minimize emissions of atmosphere pollutants and greenhouse gases.
- Develop the methods and framework to minimize environmental risks of atmosphere emissions.
- Evaluation of the risks and effectively management of operations.
- Quality emissions data.
- Assessment of climate aspects of shale gas exploitation.

Types of emissions

GREENHOUSE GASES

- Methane (CH_4)
- Carbon dioxide (CO_2)

AIR POLLUTANTS

- Nitrogen oxides (NO_x)
- Volatile organic compounds (VOCs)
- Hazardous air pollutants (HAPs)
- particulate matter (PM)
- carbon monoxide (CO)
- sulphur oxides (SO_x)

Different sources

- CH_4
  - Vented (for example release of gases during flow back)
  - Fugitive emissions from gas processing equipment (such as pneumatic controls, valves, well heads and others)
  - leakage of (raw) shalegas
- CO_2, SO_x , and NO_x
  - fossil fuel combustion
- CO, VOCs
  - Incomplete combustion.
- Ozone (O_3)
  - exploration and production operations
- PM
  - Combustion
  - Dust or soil during pad construction, due to earth movement, and traffic on access roads.

Different sources

- VOCs
  - Formed during the incomplete combustion
  - Emitted during the dehydration step of natural gas
  - Associated with fugitive emissions
  - Flaring from shale gas extraction, but in small concentrations
- Hazardous air pollutants (HAPs)
  - Benzene, toluene, ethylbenzene and xylenes.
    - fugitive emissions (is considered to be small).
    - dehydratation of the gas before entering the distribution line.
  - H_2S
    - flow back of fracturing fluids and produced water during well completion.

Emissions Assessment

- Emissions from Pre-production Stage
  - Exploration
  - Site clearing
  - Road construction
  - Drilling
  - Hydraulic fracturing
  - Well completion
  - Waste treatment

Emissions Assessment

- Emissions from Production Stage, transport, distribution and storage
  - conventional equipment (e.g. dehydration equipment, pumps and compressors)
  - leakage from gas distribution pipes.

- Emissions in the end of production and closure (plugging and abandonment of the well)
  - sealing the well
  - removal of the surface material
  - restores the production site to its previous condition.

Carbon footprint (CFP) assessment

- A mean to measure the climate impact of a certain fuel used for a certain purpose.
- M4ShaleGas tool (GHGenius) - GHGenius was developed for NRC Canada
  - Estimates Carbon Footprint of MJ/kWh shale gas for European countries
  - Compare to current fuel mix and allows to change it to see how it influence the CFP
  - Pre-defined sources and origin of fuels
- CFP very sensitive to the leakage of CH_4 during the production and distribution phase

Emission reduction techniques

Reduced Emission Completions (REC), also known as green completions

- Site preparation
  - efficient use of resources
  - transport minimization
- Drilling
  - alternative fuels for combustion engines
- Hydraulic Fracturing
  - Capture emissions from completions, liquid unloading or venting from pneumatic devices and optimization of plunger lifts could reduce vented and flared emission of natural gas in general

Emission reduction techniques

- Well completion and flow back
  - capture of fugitive gas and its use, instead of venting to the atmosphere.
  - to facilitate the recovery of the gas, the separation of the three phases of the flow back has to be performed.
  - The temporary installation of equipment designed to handle the high initial flow of water, sand, and gas.
  - sand trap to remove the solids,
  - three phase separator, which separates the water from the condensate (liquid hydrocarbons) and gas. The gas is then sent to a sales pipeline.

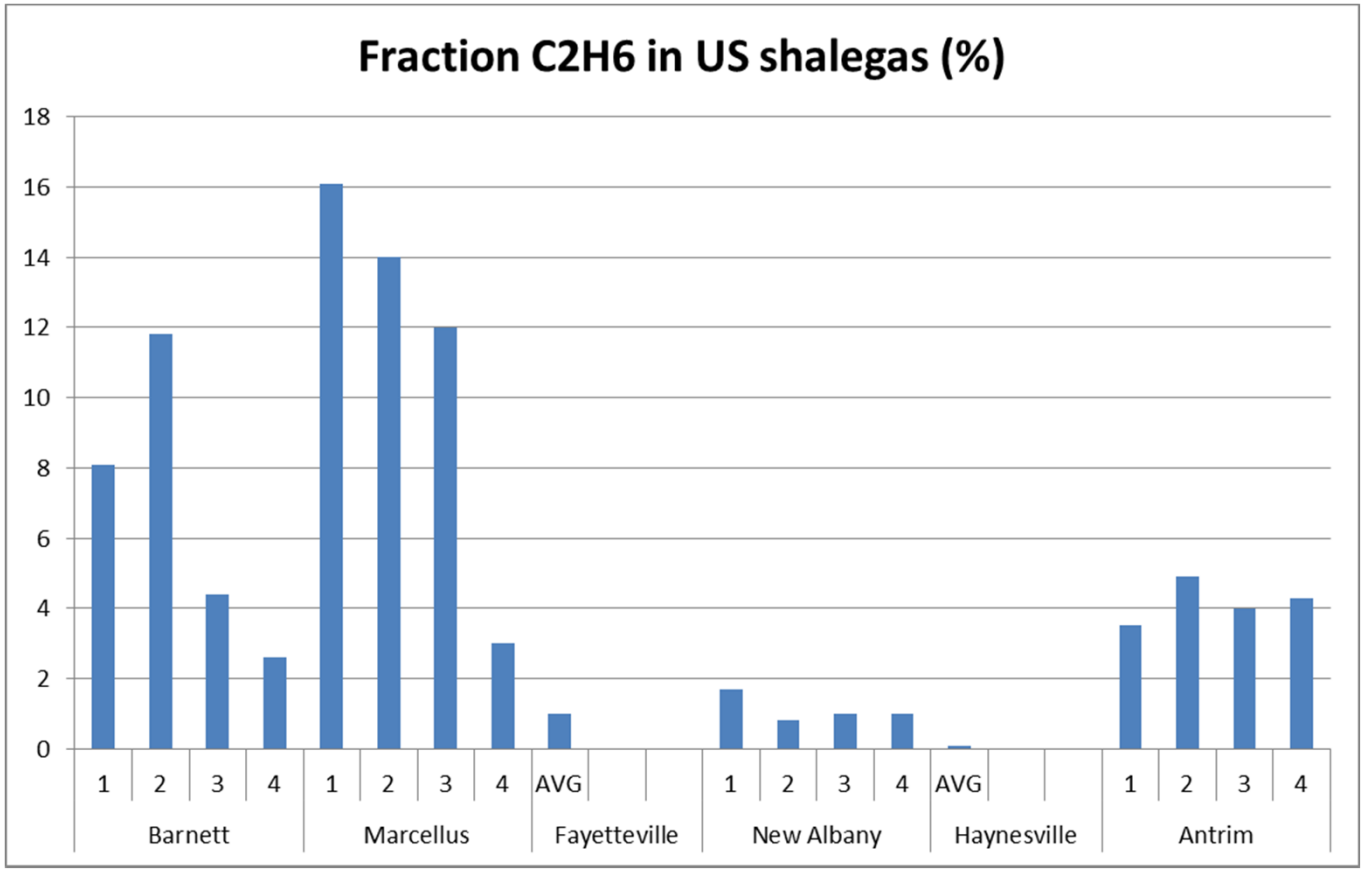
Emission reduction techniques

- Completion combustions (Flares)
  - Composition of inert gases too high
    - not economically favourable to recover the gas;
    - flare the gas until its composition is acceptable.
- Production, transport, distribution and storage
  - Improvement of the technologies applied to the conventional equipment.
    - reduction of emissions due to leakage from gas distribution pipes - improvements in the gas supply infrastructure off-site.
    - reduction of emissions from storage tanks of produced water - can be reduced using vapour recovery units.

Knowledge gaps

- Well integrity
  - Depth and width of specific well in Europe.
  - Number of wells per pad.
  - Ranges of production per well by shale formation in Europe.
  - Re-fracturing (workover) events on average or for a specific well and effects of the re-fractures on overall production.
  - Wells in Europe have sufficient gas pressure to allow application of green completion.
  - Improve wellbore cementation.
  - Processing infrastructure for captured gas on well completion.
  - Availability and experience in equipment/technology to capture the gas released on well completion and re-fracturing activity.
  - Gas compositions at various European players.

Composition of SG



Variation in US shale gas appears much wider than in EU NG sources.

Knowledge gaps

- Variability in fugitive methane emissions - rate and volume
  - Lack of transparency of emissions of methane from specific fugitive or vented sources, or from specific activities on the site
  - Environmental and health studies - cumulative effects of development on communities and land and risks of human exposure to chemical substances
- Evaluation of transportation distance of water, materials and gas, which can influence emissions
- Absence of important baseline information about environmental conditions in shale gas regions

Knowledge gaps - potential solutions

- Well integrity
  - Approaches and technologies for characterization and monitoring, need to be established locally.
  - Types of characterization and monitoring should be common and established by national legislation or by the European Commission.

- Methane leakage
  - related to conventional natural gas development
    - it is assumed that the shale gas methane leakage rates are similar of those from conventional natural gas

Knowledge gaps - potential solutions

- Lack of baseline measurements
  - Baseline observations provide a standard of the pre-shale gas development state of the environment
  - Minimising the impact of shale gas exploration on the atmosphere requires:
    - monitoring of ambient air quality prior to and during operations
    - prevention and minimization of greenhouse gases and toxic chemicals emissions by identifying emission sources of all sizes and implementing operational practices to reduce emissions

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Thank You

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